

Bath's Forgotten Gunpowder History: The Powder Mills at Woolley in the Eighteenth Century

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The manufacture of gunpowder was of major significance in Britain for four centuries, until chemical explosives began to assume a greater role from the 1870s. Gunpowder had first been seen in the western world as an agent of progress, along with the printing press and the compass, but by the mid-seventeenth century it had lost its early promise as it became obvious that despite its awesome power in battle it was not going to deter conflict and end all wars.¹ It remained however of civil importance as its use in mining, quarrying and road building developed, and its continuing significance in British trading and imperial history deserves recognition. Yet until some twenty-five years ago this subject was neglected by historians.²

My own 'discovery' of gunpowder came as I studied the papers of North Somerset gentry families for a thesis on investment in the region in the eighteenth century, and saw how much the Stracheys in particular had profited from their involvement in this business. But for background information on this mystifying industry, especially on the ingredients and process of manufacture, I had to go to books written by explosives engineers at the beginning of the twentieth century.³ There was one exception to this generalisation, and that was a charming short article in *The Countryman* (1971) by Robin Atthill, who wrote as well on this subject as he did on the Mendips in his major work.⁴ A problem remained, for as a relative newcomer I did not realise that the Woolley powder mills were so close to Bath, a circumstance which must also have surprised visitors to Bath in the eighteenth century when they learnt of this. The question of location was solved by meeting Malcolm Tucker, whose father had converted a former mill building at the site into a family home. With my documentary evidence and my co-author's practical knowledge, we were able to undertake an exploration of the surviving and hidden features in a study that was published in a national journal in 1981.⁵

Soon, interest was found to be developing in other regions, and a group began to meet at the national level, with international contacts quickly following.⁶ My own research is now concerned with this more

comprehensive approach to the subject, but the initial focus still intrigues. This has led to the publication of an article on the technology of gunpowder making in the Bristol region in the *Transactions of the Newcomen Society* (1995-6), and another on the role of gunpowder as a barter good in the Bristol slave trade in the *Transactions of the Bristol and Gloucestershire Archaeological Society* (2000).⁷ But nothing has yet appeared in a local publication on this still largely forgotten local industry, and so it seemed appropriate to remedy this by an article in *Bath History*, which I have had the honour of editing for five volumes, through ten years.

Early History, and Bath's Saltpetre Bed

It is likely that gunpowder was first made in China in the ninth century, as alchemists experimented with many ingredients in their search for the recipe that would give longevity through an 'elixir of life'. At some point, saltpetre, sulphur and charcoal were mixed together with explosive results, and so was born the 'fire-drug' or *huo yao*. This knowledge spread through Arab intermediaries to scholars of western Europe like Roger Bacon, the Ilchester-born Franciscan friar who in the 1260s wrote down the recipe for gunpowder in code, so conscious was he of its dreadful power.⁸ This code was not cracked until the early twentieth century, although by then the forbidden knowledge had long become known through others. However, the difficulty of procuring the seemingly simple ingredients imposed a limit upon gunpowder's availability, and it was in the matter of saltpetre production in particular that Bath first entered the national gunpowder records.

Saltpetre (potassium nitrate) is the most important ingredient in two respects: first in terms of bulk, rising from the 41% of Bacon's recipe to the 75% of the later standard military mix; and secondly of significance, for it introduced oxygen to the mix, thus promoting its combustion.⁹ Saltpetre's unwholesome origins lie in decaying nitrogenous waste. This 'black earth' must be heaped up in beds, layered with ashes and shells, and watered, preferably with the urine of beer-drinking men and wine-bibbers, in a closely regulated way. The liquids sprinkled on the beds leached out the nitre as they trickled through the mix, falling into pans beneath before being boiled until crystals of saltpetre were formed. But much of the saltpetre used in England in the early years was imported from northern Europe, with which there were close trading links, and until the Armada in the second half of the sixteenth century there was no sense that this dependence might be dangerous. An effort had already

been made in 1561 to learn from a German expert the particular skills needed to operate a saltpetre or nitre bed,¹⁰ and now a nation-wide system was introduced for the collection of 'black earth': dung and detritus, the riper the better. Patents were issued by the Crown, dividing the country into separate districts and authorising the appointment of saltpetremen to gather in the ordure and process it in the way described above. The operation of this system prompted many complaints, often recorded in the State Papers Domestic of the time.¹¹ The activities of the saltpetremen were greatly resented as they dug out the rich earth from dovecots, stables (the floors of which owners were forbidden to tile), and animal sheds; and gathered in human detritus near to and inside houses. When the men went too far complaints were made to the Star Chamber, as in June 1631 when it was claimed that Thomas Hilliard, who operated chiefly in Wiltshire, had 'dug for saltpetre under the beds of persons who were sick therein'. Perhaps Hilliard was too good a supplier to rein in, for only three months later he was reported again, this time for selling the King's saltpetre to some of Bristol's illicit powdermakers. Having 'some private foreknowledge' of the charge they managed to slip away: Hilliard continued at work.¹²

The saltpetre bed at Bath comes to our notice as a result of a boundary dispute. John Giffard had been appointed to collect and 'work' the nitrogenous waste to be found in Bristol and ten miles around, but in 1634 he became the subject of a complaint by Thomas Thornhill, the saltpetremen for 'the greatest part of Co. Somerset'. Perhaps from a failure to estimate the distance from Bristol correctly, or more likely because the 'city excrements' of Bath offered a rich source of 'black earth', Giffard set up one of his nitre beds there. The judgement of the Commissioners for Saltpetre was that he could continue 'his works' for that season, but when the time to 'work the same grounds' came round again, that is when a sufficient amount of ordure had built up, Thornhill was to have the working of it.¹³

What would the nitre bed in Bath have looked like? I am aware of only two items of visual evidence for the whole country: a sketch of a saltpetre works on a grant of land of 1593 to an Ipswich powdermaker (reproduced by courtesy of the Suffolk Heritage Department in the *Newcomen Transactions* already mentioned), and an archaeological drawing of the surviving earthworks from a nitre bed at Ashurst in Hampshire. Both are rectangular in shape, and enclosed on the pattern indicated by the surviving banks shown in Fig.1, some 300ft by 150ft overall. To this may be added a feature shown on the Ipswich sketch of 1593 that would also

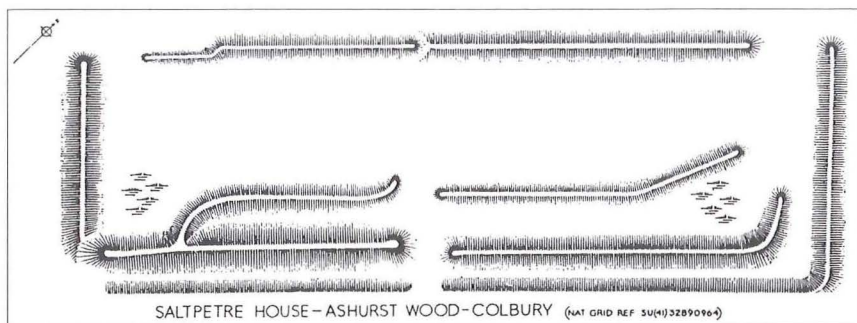


Fig.1 Surviving earthworks of the Saltpetre House at Ashurst, Hampshire, *Proceedings of the Hampshire Field Club*, vol.18 (1953), p.335.

have been seen at Bath, namely a simple arcade around the sides, covering the beds and offering protection against indiscriminate watering by rain. The Ipswich sketch also shows steam rising from the boilers which were an integral part of the process. Although perhaps on a smaller scale, there would have been boilers at Bath, to provide for a preliminary crystallization before the 'grough' saltpetre was carried off in carts commandeered by the saltpetremen, for further refinement at a larger works. We know from the State Papers that John Giffard had such a depot at Thornbury north of Bristol, because he complained in December 1634 that people were refusing to carry coal from nearby pits to his 'boiling-house' there.¹⁴ Lastly, the nitre bed at Bath would have announced its presence in a way that cannot be conveyed by an archaeological drawing, for as the Ipswich sketch shows, it would have been surrounded by 'Colde Donghills' – heaps of manure, rotting and steaming until sufficiently broken down to be lifted into the regularly aerated and watered beds. Such a feature at Bath must surely have been outside the walls of the town, perhaps between the south gate and the river where the pervasive smell of the latter may have nullified somewhat the pungency of the saltpetre bed.

Despite the efforts to establish a national system, it was clear that the saltpetre industry was not only a potent cause of civil unrest, it could not meet demand. There were therefore renewed attempts to look overseas, a challenge that was met with growing success in the course of the seventeenth century by the trade in this commodity developed by the East India Company. Again, this is a neglected aspect of our history, but by the 1620s the Company was sending home small quantities of saltpetre (finding it useful to tip it into the holds of ships as ballast), and by the 1650s it was establishing itself in Bengal, the part of India most

productive of saltpetre, where the pressures of people and their animals generated the waste that could be processed exactly as described here. Saltpetre was thus indeed a 'Commodity of Empire', and countries such as France and Sweden that lacked this connection were forced to rely on a domestic supply until at least the early nineteenth century.¹⁵

Bristol Craftsmen Powdermakers: an Urban Industry

Although a failure in terms of supply, the establishment of the saltpetre industry in the provinces led to an unexpected success in terms of the growth of the gunpowder industry outside the metropolis. The illicit purchase of saltpetre by Bristol powdermakers, already mentioned, enabled these domestic manufacturers to develop their skills and their businesses beyond the control of the Crown and its patentees. An engraving of 1630 (Fig.2) shows the small scale on which the rogue powdermakers would have operated, allowing them to move on to escape detection. It also enables us to describe the process of manufacture, which was to grow in scale as procedures were mechanised, but which did not change in the



Fig.2 Workmen making gunpowder by hand. Engraving from Hanzelet's *Pyrotechnie* of 1630, reproduced by Oscar Guttman, *Monumenta Pulveris Pyrii* (1906), Fig.22.

fundamentals. The raw materials (saltpetre, sulphur and charcoal) were assembled in the required proportions and crushed to remove lumps and stones or other foreign bodies (see the scales and sieve hanging on the wall). The workman on the left holds a pestle, but he does not just stir the ingredients in the mortar, he pounds and mixes them so that they are 'incorporated' under pressure. A little water was added to produce a paste that would be transferred to the large sieve held by the workman on the right. He must rest this on the tub, because he needs both hands to use the 'rolling pins' to force the paste through the holes punched in the leather base of the sieve. This procedure, introduced in the early fifteenth century, was known as 'cornin^g', presumably because the grains of powder thus formed resembled grains of corn. It was a step of great importance because in transit, the previously uncorned or 'serpentine' powder would separate out into its original ingredients. The sieve was also the way by which the size of the grain, as required for different purposes, could be regulated. Sometimes these holes would become clogged, and the advice in some instructions of the 1660s, that a twig should then be used to clear the blockage, perhaps explains the small branch on the corner of the table. Having been kept moist for safety and ease of handling, the grains were then dried slowly on open trays. It remained for the powder to be tested, and this may have been the purpose of the open-lidded receptacle on the table. Some of the finished product would be packed into the 'powder tester', the lid closed, and a match applied through a hole in the container. The force of the explosion would cause the lid to spring up. This was a rough and ready version of what was still being demonstrated to the Royal Society in the 1660s.

The provincial powdermakers' move to respectability began when, despite having been harassed and banned by the authorities, they responded to the Royalist call for gunpowder expertise at the beginning of the English Civil War. William Baber and some of his family moved from Bristol to Oxford, where the King had established his military headquarters in what was fast becoming a munitions-making town. Here Baber made a significant contribution to the Royalist cause, starved as it was of gunpowder because most of the powder mills, and the Tower where supplies were stored, were in and around London and so under Parliamentary control.¹⁶ William Baber returned to Bristol, held by the Royalists between 1643 and 1645, to resume gunpowder making there. It is likely he remained active for some years, because in 1668 he was still campaigning for payment by the King for powder made at Bristol and Oxford, and his later works are shown on Jacob Millerd's plan of Bristol

of the early 1670s. In the 1673 version they are drawn more elaborately than in 1671, and named as 'Baber's Tower', suggesting the owner had requested more detail from the mapmaker. The location of the works on the eastern edge of the city, south of Lawford's Gate, is significant, because having earlier been well clear of dwelling houses, they were now about to become engulfed as the town expanded. The industry itself was also facing change, from the small, often domestic scale, to the larger works needed to meet the increasing demands of Bristol, second city and thriving port.

Bristol Merchant Powdermakers: The Move to the Countryside

The pressures of encroaching dwellings and city regulations, combined with the attractions of the security and seclusion of the wooded valleys of north Somerset, offering water power and charcoal, must have made a move into the countryside seem a very attractive proposition to the Bristol gunpowder makers. The first powder mills were established at Woolley in the 1720s, nearly three miles north of the city of Bath; then came the Littleton mills in the Chew Valley south of Bristol, in the 1740s; followed by other mills nearby in the 1760s; and a further one at Moreton, now under the Chew Valley lake.¹⁷ As part of this move to the countryside we should also note the transfer in the mid-eighteenth century of the main magazine from Tower Harratz, a fortified tower in the old city wall, near the present Temple Meads Station, to a new site down river on an isolated bend of the Avon. The new location was both secure and convenient, for here surplus powder could be removed from ships coming into Bristol harbour, and cargoes of powder for the outgoing vessels could be loaded on board. These sites are worth mentioning, even briefly, because they show that the Woolley powder mills did not exist in isolation but were part of a larger network.

The new powder works were substantial complexes of buildings and water courses. There is no record of the Babers or other craftsman families taking part in this move to the countryside, perhaps because the financing of it would have been beyond them. Indeed, with heavy capital costs and revenue requirements, a new type of powdermaker now entered the industry. These were usually Bristol merchants and Somerset gentry with an eye for an opportunity, funds to invest, and good contacts within the credit network through which the port operated. They formed partnerships, with a managing partner and an office in Bristol, and a technical manager living at the site.

Partners, Managers and Workers at the Woolley Powder Mills

The Woolley Powder Mills were founded in 1722 by four partners, well-established Bristol merchants, members and officers of the Society of Merchant Venturers, shipowners, and traders in linen, iron and sugar. Three (Abraham Hooke, John Parkin, Edmund Baugh) were also engaged in the slave trade, in the operation of which gunpowder was to play an important role as a much-coveted barter good. The fourth, Harrington Gibb(e)s, had gained experience in the sugar plantations of Jamaica, returning home to become the agent of planters such as William Beckford.¹⁸ The merchant network extended to London, especially in relation to the leasing of the site, secured by arrangement with the landowner William Parkin, brother of John and himself a partner in the 1730s. The Parkins were a geographically and socially mobile family. From their base in Sheffield, John moved to Bristol where he continued as a merchant in the family iron trade, and William went to London where he was already by 1722, in the lease of the land at Woolley to the partners, described as an 'esquire' of Foster Lane. John Parkin died in 1743 and his share of the partnership was divided between his daughters, Elizabeth and Ann. Although continuing to live near Sheffield, where she bought the Ravenfield estate near Rotherham, the unmarried Elizabeth retained her interest in the gunpowder firm until her death in 1766 at the age of 63.¹⁹ Ann meanwhile had married into the Strachey family to whom her share then passed, being held by them until the early nineteenth century.²⁰

The London connections of the Stracheys were of great importance to the partners. As a young man the later Sir Henry Strachey lobbied there for contracts on their behalf, reporting in 1762 that he had as a result suffered a great deal of 'tongue and foot fatigue'. He went to India as secretary to Robert Clive, returning to become a Member of Parliament from 1770 to 1804. He held many public offices during that time and was created a baronet in 1801.²¹ The Dyers also offered useful connections in the capital. The Woolley partners had an account with James Dyer of London from 1764 until the turn of the century, probably for saltpetre traded there by the East India Company. George Dyer, a London broker, provided insurance cover in the 1780s, and became a partner in the 1790s. Robert Dyer of Bristol had become a partner in 1780, taking charge of the firm's accounts.²² But a family network was not essential for influential work in London. William Wansey, for example, a Woolley partner from 1753 to 1767, was active in the interest of all the Bristol merchants engaged in the Africa or slave trade. In 1749 he was admitted to the Merchant

Venturers in recognition of this service, 'having given a long attendance in London about the Africa trade'.²³

The Woolley partners also had useful connections with the local Members of Parliament. Robert Nugent, later Earl Nugent, a Bristol Member from 1754 to 1774, presented a petition to Parliament in 1756, seeking to overturn a wartime ban on the export of gunpowder on the grounds of its importance for the Africa trade 'which is of very great consequence to this port'.²⁴ Field Marshal Sir John Ligonier, later Lord Ligonier, one of Bath's Members of Parliament from 1748 to 1763, was particularly well-placed to give advice as he was closely connected to the Board of Ordnance for all that time. When consulted by the partners during the Seven Years War (1756-63), he was so absorbed by the problems of military supply that he delegated his response to Sir Charles Frederick, the Surveyor General at the Board. This was a wise move because Sir Charles was experienced in the problems of gunpowder making, and gave the partners sound technical advice.²⁵

The works were managed by the Worgan family: by John from at least 1740 when he became a partner with responsibility for the 'inspection and superintendancy of the works', until his death in 1747; then by his son Matthew until his death in 1793. Matthew was the nephew of Elizabeth Parkin, and on her death in 1766 he inherited her share in the works. Like many early industrialists he continued to live at the site, despite becoming a man of such substance that in Benjamin Donn's map of 1769 (Fig.3) his house assumes equal significance to the powder mill, here demoted to a single mark.²⁶ Worgan's will shows that the terms of his inheritance were not simple, for the deeds of properties at Ravenfield and York (but not Woolley) were, under the will of Mrs Elizabeth Parkins (*sic*), spinster, to be sent to Wm Parkins Bosville Esq, her next heir. Local names amongst the Worgan legatees include the Gunnings, neighbours with whom there was an early business connection through the purchase of timber for charcoal. The bequest of £5,000 to John Gunning of Old Burlington Street, London, with the pictures by 'Zuccarelli he bought for me', suggests that a later friendship still had a useful business element. The partners in the 'Gunpowder Comp. at Woolley' were each to receive a mourning ring, James Willmington [the name is not clear], his clerk, was to have £40, and the men at the works one guinea each.²⁷

With this last reference we come to the anonymous workforce – named only if death or injury at the mills was recorded in parish registers or newspaper reports. The numbers employed would never have been very large, for this was not a labour-intensive industry. A

memorandum of 1747/9 notes that twelve men were then employed, and even if the number doubled in the course of the eighteenth century with the doubling of the capital invested in buildings and equipment, this would not have been a large proportion of those living in the Swainswick Valley – a total of 348 in 1801 according to the Census that year (Woolley 80; Langridge 86; Swainswick 182).²⁸ But there were personal tragedies and the first, noted in the *British Gazette* of 23 January 1724/5, was reportedly of a scale to suggest there may have been a dangerous unfamiliarity with this hazardous industry established so recently. A night-time explosion was recorded at the powder mills near Bath, ‘by which sad accident four persons were killed outright and two others very dangerously wounded. ‘Twas remarkable, that two of the deceased persons arms were torn off by the force of the powder’. The Swainswick parish registers record the burial on 7 January of Edward Roberts and Daniell Workman, both killed at the powder mills. It may be that with the complicated parochial arrangements of the valley, the names of the other victims must be sought elsewhere. Of the two already named, the latter must have had the greater family responsibilities, for a note in the Poor Rate Accounts for 17 January 1724/5 records that for a year Elizabeth Workman was to receive 4 shillings per week, her husband having been blown up at the powder mills; and a memorandum of 1727 states that 8 guineas was placed in the hands of Mr Scudamore, churchwarden, by ‘ye gentlemen of the Powder Mills towards Apprenticing Widdow Workman’s Children’. A decade later Thomas Sandall was killed at the mills, and his burial on 26 June 1734 was recorded in the Swainswick parish register. The Sandall children, like the Workman’s, were apprenticed to trade.²⁹

By the mid-eighteenth century the workforce may have become more skilled, or luckier, for danger was twice averted. The *Bath Journal* of 29 July 1745 reported that, ‘Last Friday Evening the Powder-Mills at Woolley near this City were blown up; but as the Men employ’d there had just left off Work, it happily did no other Damage’. Five years later it was reported in the same journal that on 18 June 1750, ‘A Beam at the Powder-Mills at Woolley, this week, by some Means or other, took Fire, and burnt for some Time, but was happily extinguish’d, without doing any Damage; had it not been stop’d, near three Tons of Powder must have been blown up’. The dangers were real but most of the workforce survived, and of these James Skrine of the parish of Walcot deserves recognition for he was buried on 19 March 1797 in his 80th year, having been ‘a workman in the gunpowder mills upwards of 50 years’.³⁰

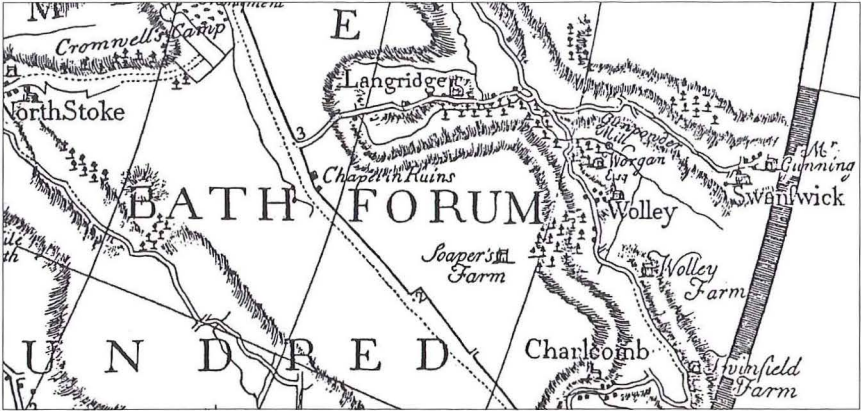


Fig.3 Part of Benjamin Donn's Map of the Country 11 Miles round the City of Bristol (1769).

The Manufacture Of Gunpowder At Woolley

In Donn's map (Fig.3), we see what a challenge the establishment of gunpowder mills at Woolley must have been. Here were woods in abundance for charcoal and an adequate supply of water for power, but the map shows a steep-sided valley and gives a sense of restriction, that was conveyed also by the Rev. John Collinson in his *History of Somerset* of 1791. He notes the narrowness of the meadows watered by the small brook that runs into the Avon below Lambridge, and observes that here '... are the gunpowder mills of Matthew Worgan Esq., situated in a deep picturesque spot, and almost environed with wood'.³¹ The limitations of the valley bottom meant that the layout of the works could not follow the more advantageous scheme seen in the 1839 tithe map of Littleton Powder Mill and at other less-restricted sites, where water was drawn from a long mill pond to power a linear series of buildings.³² Instead, at Woolley, some ingenuity had to be shown to make the best use of the site: probably by converting to gunpowder use the two corn mills (with a history going back to the Domesday Book) on the lower site, with their long narrow mill pond; and by creating a further supply of water and more workshops on the slopes above. This had the additional advantage of isolating the new main works from the valley floods to which streams in the catchment area of the Bristol Avon were liable, especially important as gunpowder is very susceptible to damp. This solution may be seen in the Woolley Tithe Map of 1839, which indicates a substantial upper mill pond supplied by water brought in by a long leat, with a scatter of buildings close by.

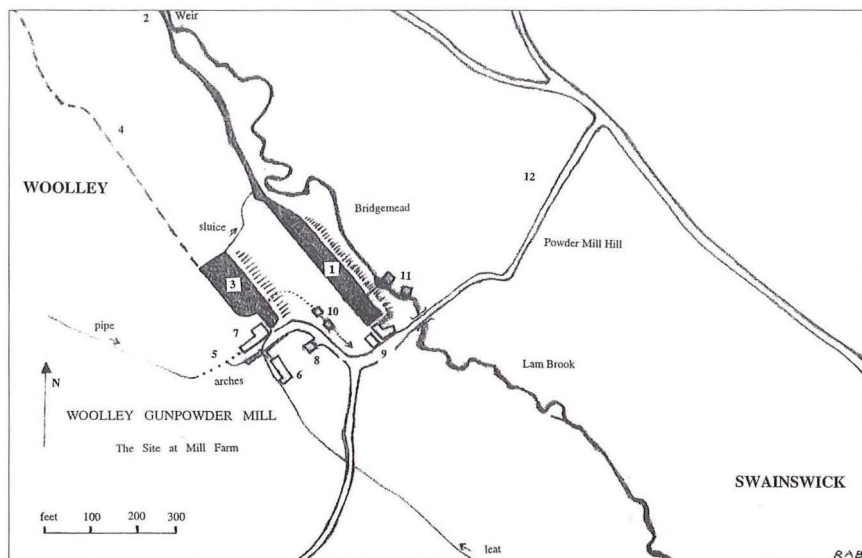


Fig.4 Plan of the Woolley Gunpowder Mills from documentary and physical evidence, drawn by Angus Buchanan. See the text for an explanation of the numbers shown here.

In pursuit of a fuller understanding of the layout of the site, a sketch map has been drawn (Fig.4). The process of interpretation is helped by the survival of the Strachey documents already noted, although since these relate chiefly to the business and financial aspects of the undertaking it is not easy to detect the often incidental information on the making of gunpowder that they also contain. It must also be explained that those buildings shown on the sketch that do still survive are now put to domestic or agricultural use, and although signs of earlier architectural features and subsequent adaptations were examined and drawn in an article already mentioned,³³ their former industrial function must remain a matter of speculation.

A glance at Fig.4 will show at once the extraordinary measures taken to bring water to the site. There is the lower mill pond (no.1 on the map), supplied by a leat that can be traced back to a weir (2); and a substantial upper mill pond (3), supplied by a leat (4) which ran for about $\frac{3}{4}$ mile to a dam at Lower Langridge (ST 743695). This leat is now largely grassed over, but it can be traced in part along the 200ft contour. It is likely that this was the new cut mentioned in a lease of 1729. This renewed the term of the first lease of 1722 and referred to a '... Cutt lately made at Woolley ... running down to the new Powder Mills there lately erected'.³⁴ It is likely that the imposing upper millpond was built between the granting of the

lease and its renewal, perhaps in 1724 when a further agreement was signed for the conveyance of water to the site.³⁵ Lastly, fresh spring water was brought into the western edge of the site by pipes and an aqueduct (5). Taken together, these arrangements were elaborate, but they are put into perspective by the comment of the managing partner in March 1801, that the annual stock taking took place in June because then ‘... our Mills usually stand still for want of Water’.³⁶

We know from the archival evidence that the manager lived on the site, and it is likely that the Mill House (6) or some earlier version of it served as the home of the Worgan family. We also know, from the annual statements of account, that saltpetre and sulphur were each stored on site in both a rough and a refined state. So there must have been storage sheds, and workshops in which boiling, crystallization, and distillation took place, probably in the buildings (7) near the Mill House, because although noxious the refining was the least dangerous part of the work, and therefore the most appropriate to house near the manager’s home. There may also have been practical reasons, for the aqueduct mentioned previously would have brought fresh spring water, suitable for the refining processes, to these buildings. Not only do the foundations of the aqueduct survive, we also have a drawing of it, sketched in 1826 by a visitor, Dulcibella Chester, and copied here (Fig.5).³⁷ The powder mill would have been out of use some twenty years by that time, but the aqueduct survived as a conduit for spring drinking water. The water tower would have been associated with its industrial function. A little downhill is a building (8), later a



stable, that lies below the level of the upper mill pond and might therefore have been supplied by it. It has undergone much alteration, but bears evidence of having housed a waterwheel. Traces of charcoal suggest that this may have been a crushing mill, a structure found at other powder mills such as those at Chilworth in Surrey where one is shown on a plan dated 1728, and so a close chronological

Fig.5 Sketch of the pipe-carrying aqueduct (no.5 on Fig.4) and water tower at the Woolley Gunpowder Mills, drawn in November 1826 by Dulcibella Chester and reproduced in the *Bath & Wilts Chronicle & Herald*, 19 September 1932.

match.³⁸ Shown at (9) are the corn mills which probably, like the stable, had at some time a gunpowder function.

After their preparation the ingredients were incorporated. The mills in which this most important stage was carried out have not yet been located on the ground, possibly because these dangerous buildings with their residue of gunpowder were dismantled when production ceased, but a possible site (10) will be suggested later. From the Memorandum of 1747/9 we learn that at Woolley there were four mills, each capable of grinding 25lbs in two hours, using water that was 'worked twice over'. This information is scrappy but telling. To receive water from the purpose-built upper mill pond, the 'grinding' mills must have been on the slopes leading away from it, and if the water was used 'twice over' there must have been two buildings, in sequence, each accommodating two incorporating mills, making four mills in all. This arrangement is shown in drawings of the late 1790s (Fig.6): in the upper sketch a central water wheel works a mill on either side, and the used water flows away in a central channel; in the lower, the upright runners are shown on the beds around which they would trundle, grinding and mixing the raw materials under pressure. At Woolley the water, having worked both sets of mills, would have drained away into the lower millpond or to the stream leading from the site.

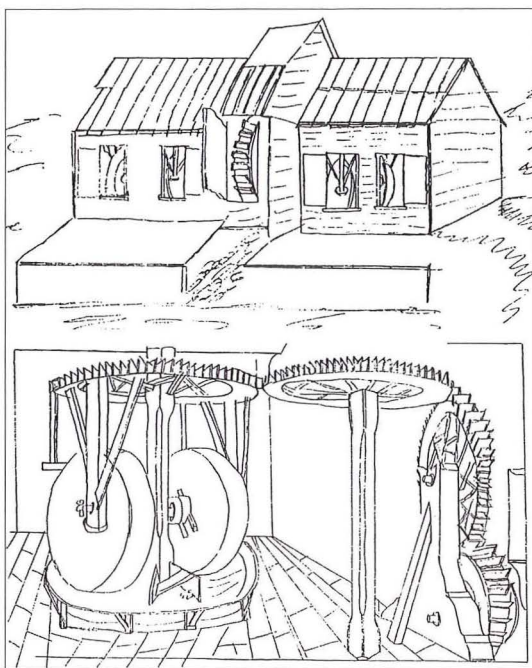


Fig.6 Water-powered incorporating mills like those at Woolley. The external view above shows the central water wheel with a mill either side; the internal view below shows the edge runners and bed. The complicated and possibly unworkable gearing suggest these may have been apprentice sketches, from John Ticking's Notebook of the later 1790s. (Reproduced from E.A. Brayley Hodgetts (ed.), *The Rise and Progress of the British Explosives Industry*, Whittaker, 1909)

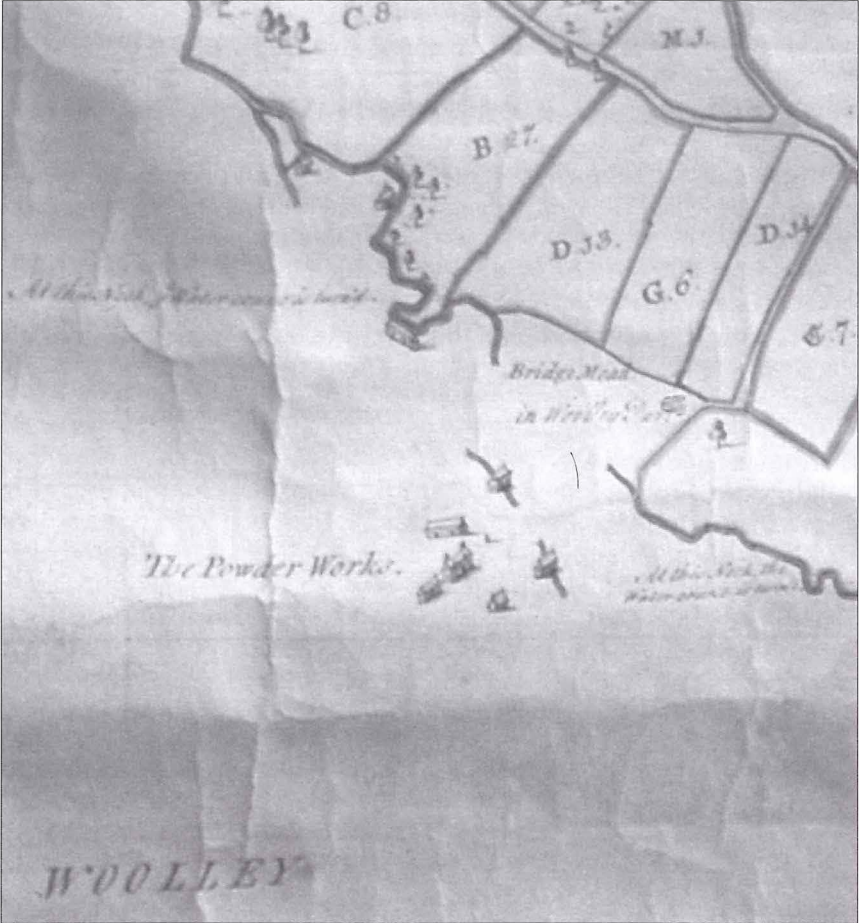


Fig.7a Representation of the Woolley Powder Mills by Robert Whittlesey, looking beyond the boundaries of the parishes of Swainswick and Batheaston, the estate of Oriol College, Oxford, which he surveyed in March 1729. (Reproduced by kind permission of the Provost and Fellows of Oriol College, Oxford)

This speculation may prove helpful in interpreting what is so far the earliest known representation of the site. We are fortunate that 'The Powder Works' are shown on an estate map drawn by Robert Whittlesey, in a survey of parts of the manors of Swainswick and Batheaston for Oriol College, Oxford, 1729. The gunpowder works were not part of this surveyor's remit, but may have been sketched in as an interesting after-

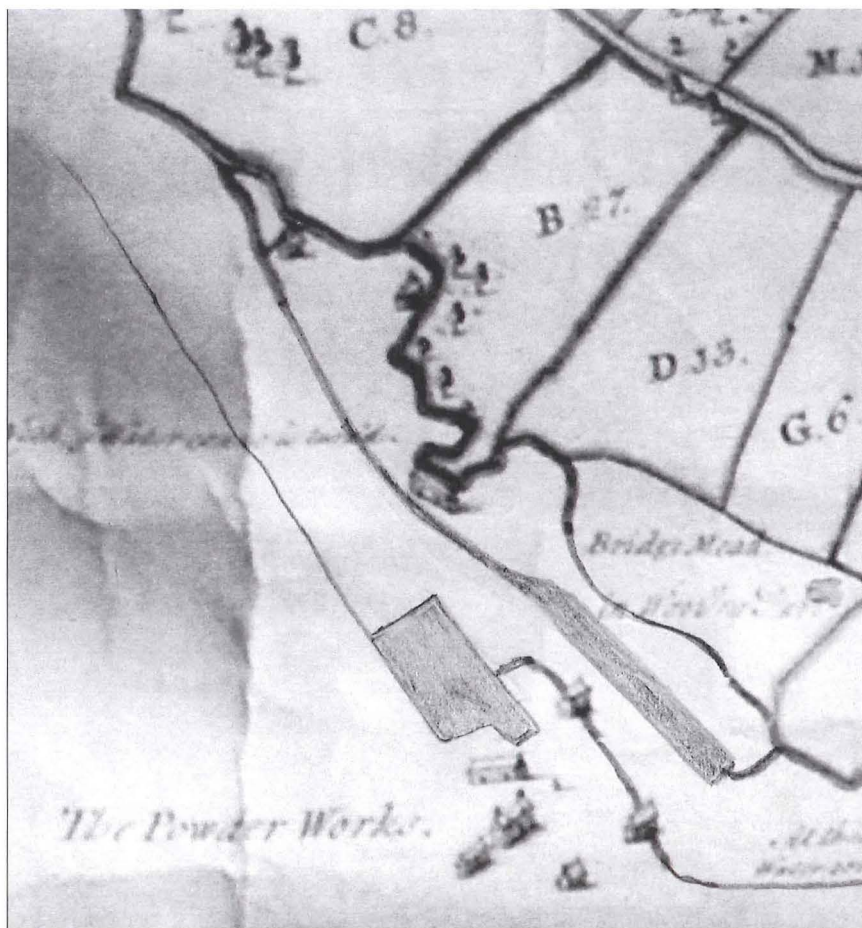


Fig.7b Conjectural interpretation of the Woolley site, placing the buildings drawn by Whittlesey within the context of the known features at the gunpowder mills.

thought, or because of some possible future significance in relation to water rights.³⁹ The layout shown in Fig.7a is very disjointed, with disrupted watercourses redeemed only by the three-dimensional aspects of the buildings. But if in Fig.7b we join up the arms of the Lam Brook as it flows through Bridge Mead, and add the two mill ponds and their leats known to have been there, we can then link in the two buildings drawn by Whittlesey, shown most significantly astride a watercourse which must at this level have issued from the upper millpond. The buildings



Fig.8 Thomas Thorpe's Map of Five Miles around the City of Bath (1742).

given authenticity by Whittlesey's map of 1729 are very probably the incorporating mills mentioned in the early documents, and discussed above. They have been added to Fig.4, as item (10). We can also add the two buildings (11), shown across the Lam or 'Wolley' Brook on Thomas Thorpe's map of 1742 (Fig.8), which may have been built as magazines away from the main site and close to the lane up Powdermill Hill (12). Based on an informed interpretation of the documentary and physical evidence, we now have in Fig.4 an acceptable representation of the site in its active years.

The ingenuity shown in using the site to its best advantage was also noticeable in the equipment introduced here, especially as this was in several cases ahead of the general practice. The system of incorporation

by pounding with a single pestle (seen in Fig.1) had by then been mechanised, with rows of pestles (known also as stamps), being raised and dropped by water power. But the Woolley partners took advantage of the move to a greenfield site in the 1720s to introduce a new and efficient system of incorporation that was ahead of its time in gunpowder making. This involved the use of edge runners, the upright stones revolving on fixed horizontal beds that may be glimpsed in Fig.6. Perhaps the partners were influenced by their familiarity with Bristol's port industries – for in the production of oil for soap, and dyewoods for cloth manufacture, as well as the snuff, glass, and sugar industries, vertical edge runners were used to crush materials. By the mid-eighteenth century most mills in the London area, where much of the military powder was produced, had followed suit, although at some of these works stamps or pestles continued in use. Concern about the danger of the over-heating of stamps and the associated explosions, led the government to introduce an Act of Parliament in 1772 (12 Geo.III c.61) outlawing this procedure, except for the production of fine shooting powders.

The partners were also innovative in the introduction of cast-iron machinery, especially edge runners and beds. These goods were all purchased from the Coalbrookdale works of Abraham Darby, through their resident agent in Bristol, Thomas Goldney. In 1759 a bed of 1½ tons and runners of 2½ tons were bought, followed in 1764 by a bed of 4 tons and runners of 5 tons. The latter purchase may have been occasioned by the failure of the partners to secure a government contract in the early 1760s. They were assured by Sir Charles Frederick of the Board of Ordnance that their runners were adequate in weight, but they suspected that those of their competitors at Faversham were more effective, being they believed of the order of 5 to 6 tons. They may have ordered this 'heavyweight' from Coalbrookdale in an effort to match them.

After incorporation the dampened 'mill cake' would be sent to a workshop with a hand-operated screw press, to increase its specific gravity and explosive power. Then it was corned, not by hand as shown previously, but in a water-powered shaking frame, before being glazed in revolving barrels to further compact and round-off the grains. The dust caused by these processes was removed by screening, which was also mechanized, taking place in gauze-covered revolving cylinders. The powder was then ready to be dried. The evidence here is particularly interesting because this was done in special dry houses, heated by stoves that were attached to an outside wall and thus separate from the main structure. The drying capacity at Woolley was already considerable when

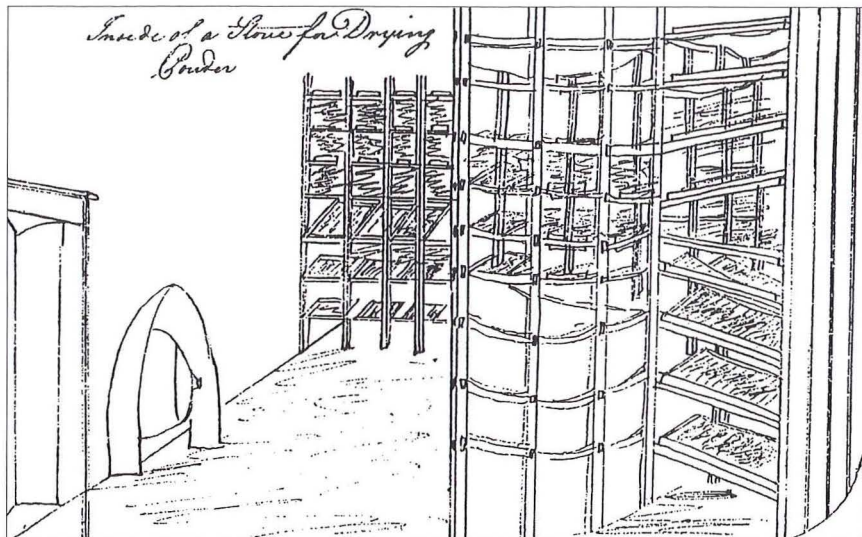


Fig.9 A Drying House, in which heat was conveyed from an adjoining stove, through a cast-iron dome or 'cockle', into a semi-circular room holding racks of powder. From Ticking's Notebook (late 1790s), in Brayley-Hodgetts (see Fig.6).

in 1750 another 'Gun Powder Stove' was ordered from Coalbrookdale, with another in 1751. The second weighed one ton, the first rather less. It is likely a third was delivered in 1763. The term 'cockle' stove appears in Goldney's Account Book to describe these deliveries, and those at the Littleton works. The term was unknown to me, but research suggested it referred to a dome through which the heat could pass safely and effectively to dry the gunpowder on racks, see Fig.9. There the matter may have rested had not my report on these features come to the attention of historians of central heating, who had previously thought that cockle stoves dated only from the early nineteenth century. The evidence from Woolley has taken the history of these stoves back by 50 years.⁴⁰

Lastly came the storage of the powder in a safe magazine before its sale through the Bristol merchants. It had seemed likely that a vault set into the hillside behind the putative refining workshops (no.7 in Fig.4) might have fulfilled this function, though it now seems possible that this could have been a 'cooling magazine' such as may be found elsewhere to house materials between processes.⁴¹ But the need for safe storage had to be met, and there is evidence from both the partners' accounts and those of Mrs Elizabeth Parkin in Sheffield, that in 1750, £500 was 'laid

out upon a new magazine'. Its location is a puzzle, but a possibility has already been noted, across the Lam Brook on what is shown on Fig.4 as Powdermill Hill, leading up and away from the works. Here we enter upon the last conundrum – how were the raw materials brought in to Woolley and the barrels of powder carried out? This was a time when river facilities were being improved in this region, but the evidence from the partners' accounts of expenditure on 'road carriers' and 'haulers', suggests that goods went by the turnpike roads rather than the Avon Navigation. One noteworthy payment in 1764 was to Mr Wiltshire 'for carriage of Petre'.⁴² The road through Tadwick to Tog Hill and so into Bristol would probably have been the route followed by these waggons, the barrels of powder covered by leather hides to reduce the effect of any explosion and blast.

The Profitability of the Woolley Gunpowder Mills

In the earlier years, whilst the works were being established and extended, the dividends were not as handsome as they were later to become. However, as the century went on, and especially in its closing decades, the large dividends due to the partners became a matter of great concern because of the difficulty of making payments in a financial system that was not as well developed as it was to become in the nineteenth century. In 1796 for example, Henry Strachey was sent £513 from Bristol in seven bills (which would each have carried a promise to pay), with a note that 'it is a matter of the greatest difficulty to secure any sort of London paper here'. The problems were worse the following year, when there had been 'very considerable sales of Gunpowder at Liverpool' (reached coastwise, and a port through which the partners sold powder in addition to Bristol), but these had been met by 'Bills at a long date'. The partners were offered interest until these became due. These high returns caused some unease – discretion was urged in 1795, for 'the dividend is so great that the utmost secrecy is necessary'. The rate in these later years was some 30%, and over the period of 60 years for which the information is available, the returns averaged 15%.⁴³ Here was a profitable cycle as merchant capital, and the revenues derived from trade (especially the Africa trade, but also general commerce such as that to be found in the trans-Atlantic markets), merchant shipping, war-time privateering, and mining, were invested in an industry whose sales enhanced those profits still further. These profits confirm that although the production of gunpowder at Woolley might seem highly localised – operating in a fairly remote valley near

Bath, some 13 difficult miles by road from Bristol, with a provincial workforce and manager living on site – yet this was also the centre of a business that operated successfully within a prosperous network of sea-borne trade. For most of the eighteenth century it must have seemed that this prosperity was unassailable, especially with the growth of mining both locally and in western regions like Cornwall, made accessible by coastal shipping and a subject requiring a separate essay, but this was not to be the case.

The End of Gunpowder Making at Woolley

Because of its reliance on international trade for most of its raw materials and markets, gunpowder making in the Bristol region was profoundly affected by changes in the world economy, especially the abolition of the slave trade in 1807. The significance of gunpowder as a barter good in this sorry trade cannot be over-emphasised: a study of the *Bristol Presentments* has revealed not only the consignments going to Ireland and beyond to the New World, but also those on the slave ships, with an average of 6000 barrels a year (each full barrel holding a 'short hundredweight' of 100 lbs) on ships bound for the west coast of Africa in the mid-1770s.⁴⁴ The largest consignment recorded was on the *Hector*, which sailed for this region in 1792 with 26,100 kegs on board. Holding one-sixteenth of a barrel or 6.25lbs, kegs were more easily handled as part-payment in this human trafficking. Perhaps this extraordinary voyage was made in anticipation of what was seen by Bristol merchants as the end of the trade, due to the forthcoming legislation. At the same time, the trans-Atlantic market was also threatened by the new powder works being set up in the United States, such as those established by the du Pont family in Delaware in 1802. The Woolley partners began to discuss a 'consolidation' with Littleton, with whom they had long had a commercial understanding for the sale of gunpowder through an office in the Bristol Exchange. A memorandum of 1802 revealed that after the expansion of the middle decades, the two firms were now together only producing as much as Woolley had done alone some 50 years earlier, which was less than 4,000 barrels per year. The firms recognized they now had a productive capacity greatly in excess of their market. The downturn was in the merchant trade rather than the military market (which after a failed attempt in the 1760s the partners never again felt the need to or tried to enter), although the expansion of the du Pont works showed that there was no lack of potential in that part of the industry. But the Bristol merchants seem to have lost their

entrepreneurial spirit. The Woolley mills closed, and those at Littleton did not survive long into the nineteenth century. They were taken over by a large firm of powdermakers from the London area, Curtis's and Harvey, and then closed down as part of a policy of rationalization. Curtis's and Harvey were themselves later taken over by I.C.I.

And so these once-flourishing manufacturing sites reverted to an agricultural use, but their historical significance deserves to be recognized and remembered. They were an unusual outpost of Bristol's industrial life, operating out in the countryside and yet fundamentally a port industry, dependent on merchants and sea routes for raw materials and markets. The Woolley Powder Mills are indeed Bath's forgotten industry, on a site that is difficult to interpret but for which we are fortunate to have some important surviving documentary and physical evidence.

Notes

- 1 Roy S. Wolper, 'The Rhetoric of Gunpowder and the Idea of Progress', *Journal of History of Ideas*, vol.31 (1970), pp.589-598.
- 2 The two most important books of the middle decades of the 20th century were by a chemist and a bio-chemist: see J.R. Partington, *A History of Greek Fire and Gunpowder* (Heffer, Cambridge, 1960) and Joseph Needham *et al.*, *Science and Civilisation in China*, vol.5, part 7, *Military Technology: the Gunpowder Epic* (Cambridge University Press, Cambridge, 1986).
- 3 For example, Oscar Guttman, *The Manufacture of Explosives*, 2 vols (Whittaker, 1895).
- 4 Robin Atthill, 'The Gunpowder Mills of North Somerset', *The Countryman* (1971), pp.134-139; *Old Mendip* (David & Charles, Newton Abbot, 1964).
- 5 B.J. Buchanan and M.T. Tucker, 'The Manufacture of Gunpowder: A Study of the Documentary and Physical Evidence Relating to the Woolley Powder Works near Bath', *Industrial Archaeology Review*, vol.5 (1981), pp.185-202.
- 6 The Gunpowder and Explosives History Group is the national society; the International Committee for the History of Technology is the international body. Please contact the author for information.
- 7 Brenda J. Buchanan, 'The Technology of Gunpowder Making in the Eighteenth Century: Evidence from the Bristol Region', *Transactions of the Newcomen Society*, vol.67 (1995-96), pp.125-159; and 'The Africa Trade and the Bristol Gunpowder Industry', *Transactions of the Bristol and Gloucestershire Archaeological Society*, vol.118 (2000), pp.133-156.
- 8 Roger Bacon's *Letter on the Secret Workings of Art and Nature, and on the Vanity of Magic* was published c.1267.
- 9 The proportions prescribed by Bacon were: saltpetre 7 parts (41.2%); sulphur 5 parts (29.4%); charcoal 5 parts (29.4%). In the closing decades of the 18th century the standard military mix came to be: 75-10-15. For mining the saltpetre proportion was usually lower, so as to shake but not shatter the rocks.

- 10 See A.R. Williams, 'The Production of Saltpetre in the Middle Ages', *Ambix*, vol.22 (1975), pp.125-133, for an account of Gerrard Honrick's recipe.
- 11 The State Papers Domestic (SPD), Charles I, vol.cclclxi, no.8, 1637, Public Record Office (PRO), for example, contain a complaint by Dean Christopher Wren, father of the architect and rector of Knoyle Magna or Episcopi, Wiltshire, that saltpetremen digging in his pigeon house had so weakened the foundations that one of the 'massy stone walls' twenty feet high had fallen in.
- 12 PRO, SPD, Charles I, vol.cxciii, no.83, 14 June 1631 and vol.cc, no.26, 24 September 1631.
- 13 PRO, SPD, Charles I, vol.cxcix, f.222, 17 July 1634.
- 14 PRO, SPD, Charles I, vol.cclxxviii, no.4, 2 December 1634.
- 15 A chapter by the present author entitled 'Saltpetre: A Commodity of Empire', in Brenda J. Buchanan (ed.), *Gunpowder, Explosives and the State: A Technological History*, is now in press with Ashgate Publishing Company.
- 16 A chapter by the present author entitled '“The Art and Mystery of Making Gunpowder”: The English Experience in the 17th and 18th Centuries', in Brett D. Steele and Tamara L. Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War through the Age of Enlightenment* (MIT Press, Cambridge, Mass., 2005), includes an account of Baber's activities.
- 17 For accounts of Woolley, Littleton and the new magazine at Shirehampton see B.J. Buchanan, 'The Technology of Gunpowder Making ... in the Bristol Region' (1995-6) and 'The Africa Trade' (2000), n.7 above. The site at Moreton was excavated before being flooded, but the opportunity to investigate the gunpowder site was lost because it was decided that, 'the chief interest of the site lies in the plan of the mediaeval house', P.A. Rahtz and E. Greenfield, *Excavations at Chew Valley Lake, Somerset* (H.M.S.O., 1977), p.114. It has been suggested there was a powder mill at Dead Mill, a mile downstream of the Woolley works, but there is so far no evidence of this.
- 18 Information on these and other Bristol merchants mentioned later comes from documents relating to their business interests, chiefly in the Somerset Record Office and Bristol Record Office, or from printed sources including: G.H. Cave, *A History of Banking in Bristol* (privately published, Bristol, 1899); John Latimer, *The Annals of Bristol in the Eighteenth Century* (privately published, Bristol, 1893; Kingsmead Reprints, Bath, 1970); Patrick McGrath, *The Merchant Venturers of Bristol* (Society of Merchant Venturers of the City of Bristol, Bristol, 1975); W.E. Minchinton, *The Trade of Bristol in the Eighteenth Century* (Bristol Record Society [BRS], vol.20, 1957) and *Politics and the Port of Bristol in the Eighteenth Century* (BRS, vol.23, 1963); David Richardson, *Bristol, Africa and the Eighteenth-Century Slave Trade to America*, 4 vols. (BRS, vol.38, 1986; vol.39, 1987; vol.42, 1991; vol.47, 1996).
- 19 For Elizabeth Parkin's business activities in the Sheffield area see B.A. Holderness, 'Elizabeth Parkin and Her Investments, 1733-66. Aspects of the Sheffield Money Market in the Eighteenth Century', *Transactions of the Hunter Archaeological Society* (1973), pp.81-87.
- 20 For the history of the family into which Ann married see C.R. Sanders, *The Strachey Family, 1588-1932* (Duke University Press, Durham, North Carolina, 1953) and Barbara Strachey, *The Strachey Line, An English Family in America, in India and at Home* (Gollancz, 1985). Neither refers to their gunpowder interests.
- 21 Information on the Strachey family's involvement with the gunpowder industry comes from papers deposited in the Somerset Record Office (Strachey Papers, DD/SH, Boxes 22, 27 & 33, not catalogued when studied). As a long-term plan these are

- being prepared by the author for publication by the Somerset Record Society, and as part of a history of the north Somerset powder mills.
- 22 The Dyers have not been found in the Bristol printed sources, and may have been a London professional family.
 - 23 The award of an honorary freedom of the city of Bristol to William Wansey places him in the select company of distinguished visitors and suggests he was not a Bristolian by birth.
 - 24 Minchinton, *Politics and the Port of Bristol*, p.85. For a portrait of Nugent, who came to live in Bath, see Susan Sloman, *Gainsborough in Bath* (Yale University Press, New Haven and London, 2002), p.81.
 - 25 See Brenda J. Buchanan on 'Sir John (later Lord) Ligonier (1680-1770), Military Commander and MP for Bath', *Bath History*, vol.VIII (Millstream Books, Bath, 2000); and on Sir Charles Frederick, 'Art and Mystery' in *The Heirs of Archimedes*, see n.16 above.
 - 26 A note added to the Indenture of Co-partnership at the Woolley Mills of June 1747 (SRO, DD/SH, Loose Deeds), records that 'whilst Matthew Worgan has management of concern at Woolly, shall have use of messuage he lived in and grounds belonging rent free as he has for some time past enjoyed same' – that is, in his father's lifetime.
 - 27 Bath Podium Library, Shickle Notebook no.20, copy of probate of will of Matthew Worgan Esq., 5 February 1794.
 - 28 *Victoria History of the Counties of England, Somerset*, vol.2 (Constable, 1911), pp.340-352.
 - 29 I should like to thank the following for helpful information : Bridgett Jones of London; David Whittock of Lower Swainswick; Marta Inskip of Bath.
 - 30 I am grateful to Bath colleagues for helpful information: Trevor Fawcett, Marek Lewcun, Marta Inskip, Susan Sloman. See the Register Book of the Parish of Swainswick, 1557-1812, and that of Woolley which, 'being decayed and almost obliterated', was transcribed by Matthew Worgan for the period 1749-1760. It is recorded that in 1757 Mrs Elizabeth Parkin, Lady of the Manor, gave a silver flagon and plate to the chapel for the communion service, together with linen, surplice and bible, and in 1761 she had a new chapel built at her own expense. Also R.E.M. Peach, *The Annals of the Parish of Swainswick with Abstracts of the Register, the Church Accounts and the Overseer's Books* (Sampson Low, 1890).
 - 31 Rev. John Collinson, *The History and Antiquities of the County of Somerset*, 3 vols. (Cruttwell, 1791), vol.1, pp.167-8.
 - 32 See also for example Brenda J.Buchanan, 'Waltham Abbey Royal Gunpowder Mills: "The Old Establishment" ', *Transactions of the Newcomen Society*, vol.70 (1998-99), pp.221-250.
 - 33 Buchanan and Tucker, 'The Manufacture of Gunpowder ... Woolley Powder Works', note 5 above.
 - 34 *Ibid.*, p.188
 - 35 I thank Marek Lewcun for the reference to the agreement of 1724.
 - 36 Buchanan and Tucker, 'The Manufacture of Gunpowder ... Woolley Powder Works', pp.189, 201.
 - 37 *The Bath & Wilts Chronicle & Herald* of September 1932 records the sad history of this sketch which was taken into the offices of the paper, reproduced in an issue, but subsequently lost.

- 38 For a copy of the Chilworth plan see Buchanan, 'The Technology of Gunpowder ... Bristol Region', p.144, note 7 above.
- 39 I would like to thank Oriol College, Oxford, for allowing me to study the maps relating to the Manor of Swainswick and the notes on the same. These show that the estate was purchased in 1521 by Dr. Richard Dudley, Fellow and sometime Senior Tutor, and later presented to the college. A special word of thanks to Mary Stacey for alerting me to the existence of this map.
- 40 For a fuller account of the technological innovations at Woolley see Buchanan, 'The Technology of Gunpowder ... the Bristol Region', note 7 above.
- 41 George W. Rains, *History of the Confederate Powder Works* (Augusta, Georgia, 1882), p.21.
- 42 See B.J.Buchanan, 'The Great Bath Road, 1700-1830', *Bath History*, vol.IV (Millstream Books, Bath, 1992) and 'The Avon Navigation and the Inland Port of Bath', *Bath History*, vol.VI (Millstream Books, Bath, 1996).
- 43 Buchanan, 'The Africa Trade', p.149, note 7 above.
- 44 *Ibid.*, pp.133-137. The *Bristol Presentments* in Bristol Central Library carry information on ships leaving Bristol for a number of years.